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PROCEEDINGS.—SESSION 1925-26

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Contributions from members on matters of general interest are invited, and if suitable will be paid for at the rate of 10s. 6d. per page. Articles may take the form of descriptions of new plant or tools, interesting workshop methods and production problems, or shop organisation systems. All communications, other than those relating to advertisements, should be addressed to the Hon. Editor, Mr. E. D. Ball, 20, Lushington Road, Harlesden, N.W.10.

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EDITORIAL.

SEVERAL members resident in the Lancashire area have expressed a desire for the formation of a Northern branch of the Institution, and this matter will be brought before the Council at an early date. Meanwhile it may not be inopportune to consider what is required to launch an active branch.

First of all, of course, a good nucleus of members must be obtained within a reasonable distance of a suitable centre, and amongst them must be one who has sufficient initiative and enterprise to fill the office of President of the Branch. Other members are also required who are prepared to work on a Local Committee which shall be responsible for the development of the branch and for arranging local meetings and obtaining suitable papers. Another requirement is to find an individual who is prepared to undertake the somewhat onerous duties of Local Secretary. As the Institution is at present constituted, these duties include the conduct of all correspondence connected with the branch, attendance at all meetings and committees for the purpose of taking minutes, the collection of subscriptions from local members, and responsibility to the Council for conducting all the ordinary business of the branch in accordance with the Rules.

At present there are a number of members who are desirous of forming the branch, but few constructive suggestions have been received. Manchester is most generally favoured as a centre, and the General Secretary will therefore be pleased to hear from interested members in or around Manchester, so that definite proposals can be placed before the Council.

DIE CASTING PRACTICE.

By Mr. A. H. Mundey, of Fry's Metal Foundries, Ltd.

IN introducing Mr. Mundey, the President remarked that the subject of die casting was of great interest to many of the members, but was generally regarded as one which was "wrapped in mystery." The lecturer, in opening his address, which was not presented in the form of a written paper, but was given in conversational style, remarked that, whilst he was conscious that it was very bad form to contradict one's Chairman, he felt bound to state that there was no inherent mystery in the process of die casting. Such secrets as did exist were those associated with the workers, designers, tool makers, and casters. Many persons were disposed to enshroud the industry with mystery, but this was for commercial reasons; the real trade secrets existed in the skill and experience of the designers and craftsmen.

Die casting was really an extension of that branch of industry with which we were all so familiar—ordinary foundry work. It was only fair for a lecturer to commence by giving a definition of his subject, but this was not altogether easy.

Modern metallurgists defined die casting as the production of finished castings by pouring molten metal, flowing by gravity or under external pressure, into a permanent mould. There had for a long time been a tendency to separate the practice into two sections, the casting by pouring into a metallic mould being called Chill Casting, and the casting into a metallic mould under pressure being designated Die Casting. The Non-Ferrous Research Association and other authoritative bodies had, however, recognised both sections as belonging to the general description of die casting, and they were now usually distinguished as Gravity Die Casting and Pressure Die Casting.

The origin of the process was rather obscure. It would appear that there was a competition between the early process of type founding and that of bullet casting as to the first use of this method of production. Certainly as far back as 1838 an actual machine for casting type was made by Bruce, and in 1885 Otto Mergenthaler introduced the Linotype Machine. The adoption of the process for general manufacturing purposes seemed to be due to engineers who were engaged in devising machinery for moulding rubber. The numerous applications of the art which were to be described would, however, justify us in looking upon

it now as having developed into a definite branch of engineering practice.

Advantages of die casting were numerous. The first and greatest of these was the fact that the castings were accurately finished when taken from the die. No machining was required; holes, recesses, and intricate fitments could be cast with absolute

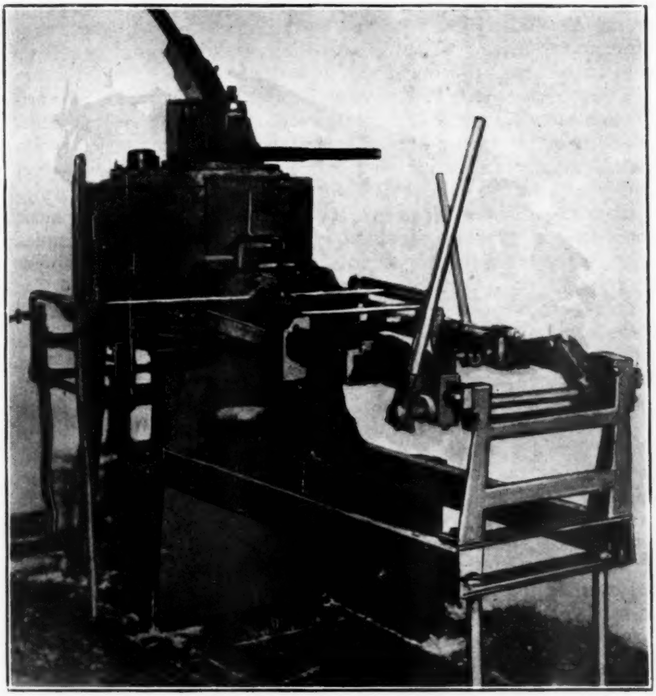


Fig. 1.—The Soss machine.

faithfulness. Internal and external screw threads were produced. Inserts and bushes might be cast in, and, finally, the external surface or skin was in a satisfactory and highly finished condition sufficient for many purposes without further treatment. If required, however, the metal could be polished and plated and lacquered or coloured to suit the requirements of the work and to afford the necessary protection from atmospheric conditions.

The alloys employed varied considerably. That generally used for pressure die casting was a zinc base alloy frequently described as white brass. It was about as strong as cast iron, and contained 80-85 per cent. zinc, about 5 per cent. copper, 10 per cent. tin, with a very small quantity of aluminium. It would be readily understood that the alloys employed were usually those of rather low melting point, as it was only in such circumstances that one could be fairly sure that the dies or permanent moulds would not be rapidly and seriously injured by the hot metal. In these conditions very many thousands of castings could be produced from one die without adjustment or renovation.

Other alloys were used; practically the whole range of antifriction metals, from the highest grade, containing 93 per cent. of tin, the remainder antimony and copper, down to magnolia metal, with about 80 per cent. of lead, 15 per cent. of copper, and 5 per cent. of tin, lent themselves perfectly to die casting. Even lead-antimony alloys specially designed to resist atmospheric conditions in exposed situations could be die cast, and samples were on the table for inspection. Many special alloys containing very large proportions of tin hardened by antimony, and other metals were die cast with success. Next came the light alloys, those containing a very large proportion of aluminium being looked upon as aluminium alloys, that known as L.8 containing from 8-12 per cent. copper, and the remainder aluminium, being the most widely employed.

Yellow metals were also die cast, but this was almost exclusively by the gravity process. Aluminium bronze was the alloy chiefly used—90-95 per cent. of copper, with 10-5 per cent. of aluminium. The copper-zinc alloys were sometimes die cast, those of the 60 per cent. copper, 40 per cent. zinc, series being more readily cast than the ordinary 70-30 per cent. brass, but this class of alloy was by no means easy to operate.

Reverting to the commonly used zinc base metal, a word should be said about the presence and function of aluminium. A small quantity was necessary, as it served not only to deoxidise the metal, but also to prevent the galvanising of the mould and cores, and also the eating away of the plunger and cylinder in the pumping mechanism of the casting machine. It must be carefully observed that, although a small quantity of aluminium, not, as a rule, exceeding 1 per cent. and frequently a proportion much lower, was an advantage, it did not follow that a larger proportion would improve the conditions of the casting.

One of the chief anxieties in connection with the employment of the die casting had been the storage cracking, or season cracking, as it was sometimes termed. In a very large measure this had been traced to the presence of an excessive amount of aluminium. Very hard compounds of zinc-aluminium crystals

occurred in the alloy, which tended to form brittle areas. These were not only a source of great weakness and danger, but were probably the starting places for the spontaneous cracking.

Aluminium alloys or light alloys were growing in favour and would undoubtedly displace the zinc base alloys for many purposes were it not that the casting of aluminium under pressure was, as a rule, much more difficult than the alloy in more common use. The members would appreciate the difficulty when it was considered that the melting point of aluminium was about 630 deg. cent., and that all the alloys used were not much below this. This temperature made casting difficult, and the wear and tear on the plunger and cylinder of the pump was so serious that this

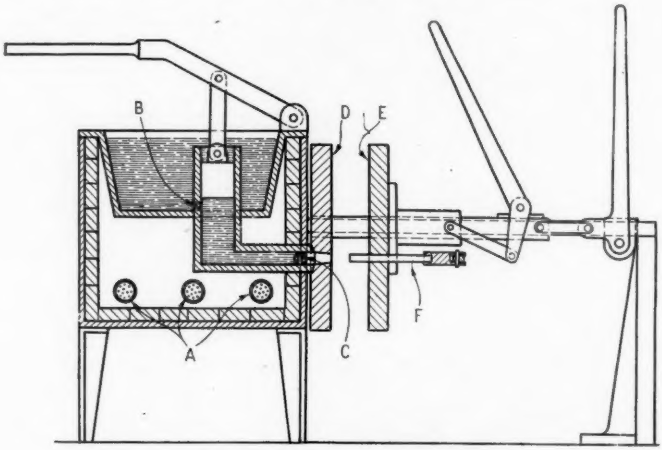


Fig. 2.—Section through the Soss machine.

part of the mechanism was frequently replaced by mechanism for utilising air pressure. The use of air pressure as an alternative to the pump and plunger was, however, attended by the danger of unsound castings due to blow holes or included air. The engineer must, therefore, be guided by his experience in selecting the material and method to suit the particular casting, those of an intricate nature being the most difficult to make sound.

Too strict standardisation of alloys as to composition was inadvisable, as it was found necessary to vary the proportions to a marked extent in special cases; thus the zinc base alloy sometimes contained a great deal more tin than the 10 per cent. usually prescribed. This must, of course, be limited, if only on account of

expense, for with tin at £286 per ton it was obviously undesirable to waste money by including too great a proportion of this metal.

There was no doubt that the most difficult section of all was the design and manufacture of the tools or dies, but, even before this, one had to legislate for the active co-operation of the designer of the part to be cast. It had been truly said that the greatest economies in engineering construction were those carried out in the drawing office. In die casting, this was of the utmost importance, although the lecturer felt sure, however, that many of the gentlemen present who were primarily responsible for production would agree that one of the ever-present sources of trouble was the difficulty of ensuring the co-operation of the designer with a view to simplicity in manufacture.

So often the character of an article could be modified without detriment to its usefulness in application and at the same time provide for ease of manufacture. In die casting, this was especially evident in connection with details which required to be cored. If the cores could not be withdrawn by a simple movement, great expense and trouble ensued. Again, the active co-operation of the metallurgist with the designer and the actual manufacturer must be a cardinal feature.

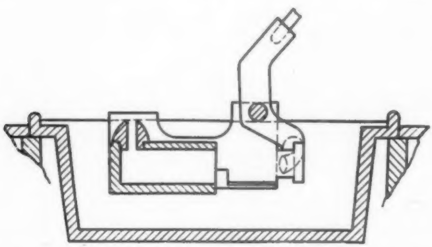


Fig. 3.—The essential elements of the vertical machine.

At a recent meeting of the London Section of the Institute of Metals, Mr. Hoblyn, of Vauxhall Motors, Ltd., strenuously emphasised this point. It was not contended that every engineer should be required to possess a profound knowledge of the more academic sides of metallurgy, but that he should have an adequate and workable acquaintance with the phenomenon of cooling and solidification of fluid metals.

The lecturer then proceeded to describe the actual method of die casting, commencing with the early class of moulds employed for the manufacture of bullets and then type. An ordinary two-part mould carefully dowelled together in correct register was first employed. In this case the metal was simply poured in.

Then the first type-casting machines were introduced, the moulds being essentially three part—two for the body and one for the face of the type.

The introduction of the linotype machine and others of its class came next, and, finally, the monotype machine. The members would, however, be more interested professionally in those which

Fig. 4.—A vertical machine in operation.

were employed for general engineering rather than the printing industry.

The most elementary machine used for producing pressure die castings in this group was that invented between forty and fifty years ago. It consisted of a vessel somewhat like a tea-pot, in which the lid was replaced by a plunger, the molten metal being squirted out of the spout into the die by striking the plunger on the top by the hand or a mallet. The evolution of the various

machines was then illustrated by a series of lantern slides, a selection of which are reproduced.

In fig. 1 is shown a general view of the Soss machine, which is of the horizontal type. This illustration shows the heating chamber, within which is the molten pot with plunger and cylinder. The lever for operating the pump is shown at the upper part of the heating chamber, whilst the levers and link motions for operating the moving parts of the die, together with the toggle for clamping the two parts of the die in position, are shown towards the front of the machine.

Fig. 5.—A group of vertical machines.

A diagrammatic section through the heating chamber and metal container of the machine is shown in fig. 2. The chamber is lined with firebrick or other refractory substance, and is heated by means of gas burners, as shown at A. A cast-iron metal container is used and is supported so that the pump barrel projects through the bottom of the container, so that the metal can flow into the barrel through an aperture B when the plunger is raised. This aperture is closed as soon as the plunger is forced downwards, and the molten metal is ejected into the die through the orifice C. The two parts of the die are mounted on the plates

D and E, which are operated by means of the levers and links shown. The sprue cutter and attachment for operating are indicated at F.

A section through the essential elements of the heating chamber, metal container, and pump mechanism of the vertical machine is shown in fig. 3. In this case the pump plunger works horizontally, and the metal is projected into the dies through the orifice in a vertical direction. Machines of this character working on the same principle are used in the works of Fry's Metal Foundries, Ltd., one such machine being shown in actual operation in fig. 4. In this illustration the dies are shown clamped together with the

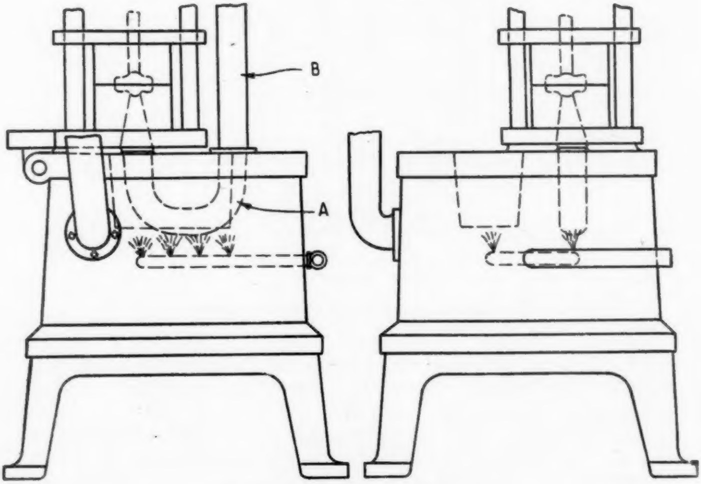


Fig. 6.—The Wagner machine.

swinging plate in position over the metal container. An operating lever for the pump is shown in the foreground, the small apron plate at the bottom of the lever being provided to protect the legs of the workmen against accidental splashing of metal.

A general view of a group of vertical casting machines is shown in fig. 5, which illustrates the method of mounting the die plates, which in this case are shown in the loading position.

The principle of the Wagner machine will be apparent from fig. 6, which shows the essential parts of the machine diagrammatically. A goose neck metal container, A, is used and filled from the metal pot by ladling, both the pot and the metal container being heated by gas burners. The die plate is pivoted and

swung into position, whilst the air supply is coupled up with the pipe B. In this way the metal is forced upwards from the goose neck container into the die.

An electrically heated pot is shown in fig. 7. In this case the container of refractory material is surrounded by heating coils which are carefully wound and lagged. The principle adopted is similar to that of a chemist's wash bottle. Air under pressure

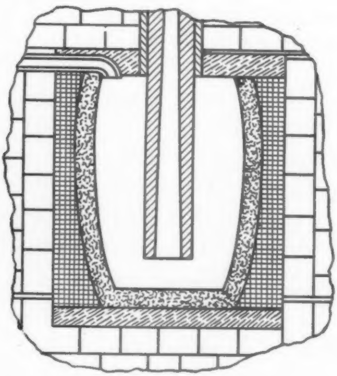


Fig. 7.—An electrically heated container

enters the top of the pot or container, so that the pressure exerted upon the surface of the metal forces a stream of molten alloy up the centre of the tube into the die.

The lecturer gave a short description illustrated by numerous slides of the production of stereotype plates as carried out in the principal newspaper offices. The growth of the industry from the most primitive production to the modern Senior and Junior Auto-plate machines and the Winken machine was traced.

HIGH PRECISION JIG BORING.

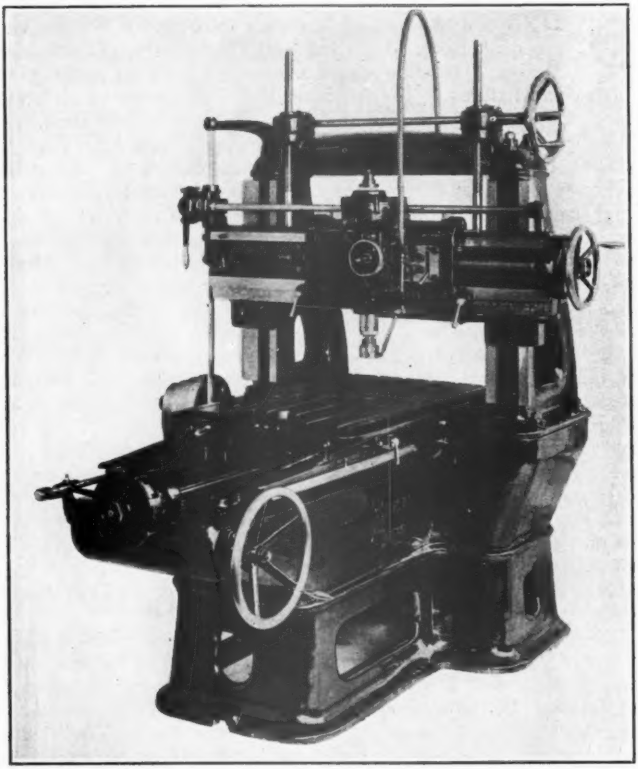
DURING the discussion following Mr. E. W. Hancock's excellent paper on "Jig and Special Purpose Machine Design," mention was made of the cost of making jig plates and fixtures to the requisite degree of accuracy. A statement emphasising the importance of the last "half thou." in production called forth some amused comment from some members during the discussion. Workmanship of this order admittedly represents a high grade in production, but on tool-room work a higher degree of accuracy is frequently essential. A further fact which was apparent from the discussion was that some members were not aware of the possibilities of the jig boring and locating machine made by the Société Genevoise for highly accurate tool-room work. A brief description of one form of this machine is therefore given below.

A view of the No. 5 jig boring machine is shown in the illustration, from which it may be seen that it consists essentially of a saddle carrying a boring spindle which is movable over a work-table capable of movement in a direction at right angles. These two movements provide for working to rectangular co-ordinates in setting out or boring a jig plate or fixture. To obtain the degree of accuracy necessary in controlling the movements of the saddle and table, some special features have been embodied in the design of the machine, in addition to extreme accuracy of workmanship throughout. It is claimed, and apparently the claim is well substantiated, that the mean accuracy of work carried out by an operator of average skill is within 0·0004in.

It will be realised that the accuracy of the settings depends primarily on the perfection of the screws controlling the two units, the accuracy and fit of the nuts, the condition of the slideways, etc. Under ordinary conditions it is impossible to produce a micrometer screw of sufficient length to within the required degree of accuracy, and a special automatic corrector has therefore been adopted which applies the necessary correction at each point in the length of the screw.

In practice the screws are threaded after hardening on special lathes which enable the pitch error to be reduced to the order of 0·001in. in each metre of threaded length. Following this, the screws are inspected and a diagram showing the exact error at every point along each screw is plotted. This diagram is then used as the basis for producing a steel plate cam of the same

length as the distance of the travel provided for the table or boring spindle, the micrometer screw error being reproduced to an enlarged scale. The cam thus obtained is secured to the side of the work-table or saddle, whilst the cam follower is carried on the end of a lever, the opposite extremity of which is coupled to a



No. 5 jig boring locating machine.

vernier mounted so as to be capable of rotation about the end of the micrometer screw. A circular scale engraved on a drum, which is rigidly secured to the screw, is adjacent to the graduations on the vernier. Thus, as the work-table or saddle is moved along, the lever follows the profile of the corrector, and the vernier is

automatically adjusted so that the readings on the drum are correct at any point. It should be mentioned that the screws are mounted in hardened bushes which are carefully rectified so that no cam action can take place.

In addition to this provision, another feature is the method of minimising wear on the screws, whilst the possibility of play in the nut adversely affecting the readings has also been overcome. For this purpose the nuts, which are anchored in the slides, are provided with telescopic locknuts controlled by handles on the machine. These impart a clamping action to the locknuts after adjustment, so that the threads of the screw are pressed against the flanks of the threads in the corresponding nut. This device also serves to lock the screw to prevent movement whilst the boring operation is in progress.

The construction of the tool spindle is obviously of first importance. To facilitate the attainment of alignment in the bearings, these are arranged in a long sleeve which has a vertical movement only, provision being made for taking up backlash in the sleeves and bearings. The drive to the spindle is also arranged so that any possible tangential strain from the driving pinions is eliminated.

In using the machine for ordinary work the rough setting is facilitated by longitudinal scales which are attached to the slides so that they may be adjusted over a sufficient range to enable the operator to read from a whole number as a starting point for the work in hand. These scales may be graduated in millimetres or tenths of an inch as desired, whilst the drums on the micrometer screws are graduated to read in tenths and hundredths of a millimetre or corresponding fractions of an inch. By means of the verniers, readings to thousandths of a millimetre or ten thousandths of an inch may be made with comparative ease.

The utility of this machine is considerably enhanced by a number of accessories, which include a locating microscope, an auxiliary high speed spindle, and a dividing work-table. The microscope can be secured to the tool spindle and focussed on a standard scale or gauge clamped to the work-table so that at any time the accuracy of the micrometer screw can be checked by displacing the table and observing the scale through the microscope. By means of the microscope an accurate location can also be obtained, for working from a scribed centre line or centre punch marked upon the work. Further, this accessory may be used for setting the verniers to zero when it is desired to work from the machined edges of a component.

The auxiliary high speed spindle is supplied on account of the somewhat limited range of speeds provided for the main spindle. The main spindle is intended for boring holes from a $\frac{1}{4}$in. diameter up to the largest size ordinarily encountered in making jig plates,

and the speeds are thus comparatively low. With the high speed spindle, however, small holes under 0·250in. diameter can be drilled quickly and accurately. The spindle is mounted on the carriage at a definite distance from the main spindle, so that it is only necessary to add or subtract this from the reading on the cross rail micrometer screw. A flexible shaft coupled to the vertical driving shaft by means of a friction clutch serves to drive the auxiliary spindle up to a maximum speed of 2,060 r.p.m.

Another useful attachment is the dividing table, by means of which work may be carried out to equal accuracy from polar co-ordinates, or holes may be bored on pitch circles, etc. This table is set truly central with the tool spindle by means of a sensitive spirit level mounted in a frame which is supported between centres in the tool spindle and the table respectively. The level is extremely sensitive, and it is claimed that a displacement of 0·00005in. may be easily detected, assuming that the machine itself is accurately levelled. For levelling the machine table special groups of screws connecting the bed of the machine to the base casting are provided. Each group is formed by two concentric screws, one of which lifts the bed plate of the machine whilst the other serves to clamp the bed to the base to prevent any disturbance due to vibration, etc.

In addition to the above machine, a larger pattern—the No. 6—has recently been introduced. This machine embodies a number of improvements, in addition to being of considerably larger capacity.

Discussion on Mr. E. W. Hancock's Paper Entitled "Jig and Special Purpose Machine Design."

THE PRESIDENT, in expressing the thanks of the meeting to the author, said the paper had obviously been prepared by one who had been "up against it" himself, and appreciated the little difficulties which the production men in the shop were up against. It was a great relief to listen to a paper which was practical, after the many purely theoretical perorations that were given from time to time. There were three points in the paper which were very much after his own heart. The first was the question of robust fixtures. One often saw really excellently designed fixtures from the functioning point of view which were ruined right at the conception by the lack of vision on the part of the designers as to the robustness required. Fixtures were often built up out of standard cast-iron blocks at considerable expense when a comparatively few shillings on a pattern would give a fixture infinitely more robust. The second point was also one in which he was a great believer, and he was glad to say that most jig designers were coming round to the same point of view now, viz., the necessity in accurate production of having a jig in which the means of accuracy is embodied in the design instead of depending on the alignment of the machine by driving through universal joints. This not only gives more accurate production, but it undoubtedly relieves the machine tool itself of quite a lot of wear and tear, and it is quite essential for good and quick production. The third point, and by no means the least—in fact, he should say it was the most important of all—was the absolute necessity, which the author emphasised, of accurate first operations. It was a fact that inaccuracy in the first operation can never be eliminated by any ordinary machine shop methods, even by grinding, and to obtain an accurate finished article it is highly essential that full accuracy should be given to the article from the beginning. The point as to the financial allowance for fixtures was one of the most difficult things which the production engineer was faced with. It was very difficult to come to a final decision as to where money is really worth spending on a fixture and where it is not. Of course, there was the first consideration of the quantity to be made and the amount of time that could be saved in the manufacture of the part, but it was also necessary to consider the

question of the costliness of the part and the need for keeping scrap to the minimum. If the parts were cheap, possibly they could be sacrificed to a cheaper jig. Another point which had to be considered was the question of assembly, and that was often lost sight of. One instance of what he meant was mentioned in the paper, *i.e.*, the need for adjusting connecting rods. That might not be an important point, but he mentioned it because it illustrated what he was driving at. A certain amount of time had been spent in adjusting these connecting rods. This took us right back to the question of the design of the fixtures, and the methods employed for producing these connecting rods, because obviously, if these rods had been produced sufficiently accurately, there would not have been any need for that adjustment. The whole matter, of course, goes a good deal farther than that, but the point would illustrate what he meant, when he said it is not only a question of the actual cost of the production of the part. That, again, was governed by the limits put on the drawing by the drawing office, and there, again, in all works organisations it was essential that there should be a better feeling and more co-operation between the works staffs and the drawing office. The more the better. It seemed to be the practice in engineering manufacture for the works staff and the drawing office to hold themselves aloof from one another, and the result was that in this country there is not that co-operation between the producer and the designer which there ought to be. Yet it was such an important factor in manufacture. In the same way, there was often a certain amount of pulling in opposite directions on the part of the planning department and the jig and tool design department, and for that reason he had always been a believer in mixing the two classes of men together as much as possible, and keeping the two departments as closely in touch as possible. No doubt a good tool and jig designer was not specially interested in planning from the purely planning point of view. He thought the design of jigs and tools the most important thing, whilst the planning engineer thought the planning is the most important thing, and he, on his part, did not give that attention to the little difficulties of the jig designer. The result was that, unless these men were brought together, they would never work together in double harness. There was one little point in the paper with which he did not quite agree, and that was the stress laid on the term "ingenious jigs." There were too many jig and tool designers who overlooked the importance of making their jigs as simple as possible, because most jigs could be simple. It was very often much better to design a simple fixture that can be easily replaced than an ingenious fixture which cost more and perhaps gave a little quicker production but is difficult to replace, and therefore was often used long after it should be, taking into account wear and

tear. This question was coupled in the paper with a reference to the cost of jigs. The same thing applied here. The prime cost of jigs and the ingenuity put in them were always dependent upon each other. One remark in the paper which struck him was the reference to the use of worn-out machines, especially in regard to drilling spindles. In this country, unfortunately, we still stuck to the old idea that a machine should be run to pieces. In his opinion, machines were not changed nearly often enough, and tens of thousands of pounds were thrown away weekly here in higher production costs because boards of directors would not realise that it does not pay to go on using machines when they are worn out. He had repeatedly come across cases where it had been possible to prove that an expenditure of a few hundred pounds on a new machine would pay in better and quicker production and a reduction in scrap, and save its cost well inside a year. Although the paper dealt largely with jigs, there was one matter which might have been mentioned. That was a jig borer, which he was sorry to say had come into this country from abroad, and he only wished that it had been devised in this country. This was produced by the Société Genevoise, and had practically revolutionised the considerations which could be given to the financial allowances. It was wonderful what that machine would do, and anyone who had not investigated it and was responsible for the upkeep and supply of fixtures in factories should certainly have a look at it, because it was a most useful machine and a tremendous money-saver. There was a term used in the paper of which he was a great user himself, viz., the last half thou. If we could only get our designers to realise—and he was not speaking of jig and tool design, but about component designers—what that last half thou. means, he was perfectly certain we should not see the long string of noughts that is now so common. The difference between the last half thou. and the thou. was equivalent to about a couple of thousandths. In other words, it was quite as easy to increase the accuracy of a part from 0·003 to 0·001 as it was from 0·001 to half a thou. He was not speaking of ordinary plain cylindrical grinding and that sort of work. He was speaking of producing parts with dimensions on faces or between holes to within that half thou. limit, which is, of necessity, produced from fixtures. It was a very difficult thing to take a piece out of a machine, even a cylindrical piece, and to produce the part in a centre lathe, and set it up in a grinding machine, and then find it true within half a thou. That might sound an exaggeration, but many of those present knew as much about that as he did, and he had always held that view, and all designs should be made such that the last half thou. of purely cylindrical parts is spurned like the plague. He did not know what the author meant when he said that the design of jigs and

tools should be to the accuracies required in the component produced. This seemed to imply that the matter of tolerances in the assembly was the responsibility of the jig and tool designer, but in his view the jig and tool designer already had enough to load him down already without having to worry about that. He should, of course, consider tolerances from the production point of view, and he should approach the drawing office whenever the tolerances given make a part difficult to produce. If he were wise, he would always insist on the drawing office fixing the limits, and not leaving it to him. That same spirit should be carried right through production. To-day, in far too many engineering works, the standard of production was fixed by what the shop thought it could produce. An inspector might want to reject something because the drawing called for something to be produced within a thou., and it was produced within a thou. and a quarter. Naturally, the inspector wanted to reject it, but in 99 cases out of 100 the shopman would say that the inspector must be mad or dotty or something like that, and the inspector would not reject. We could not blame the inspector, perhaps, for giving way, but the consequence was that the next time the difference was greater, and a little later it was more, and gradually a degenerated state of production was arrived at, and, in his opinion, not a penny piece was saved by it. If it were necessary to produce a part within a tolerance of one thou., and that was the tolerance on the drawing, not only should the inspection department insist upon it, but those in charge of the shop should be the first people to uphold the inspector. One very important point was not dealt with in the paper, viz., the sending in of fixtures for repair. Everybody knew the difficulty of getting the shop to send their fixtures into the tool room for repair or upkeep when they first began to need it. The usual time the fixtures begin to get examined in that way was when the components come under the eye of the inspector, and are being pulled up for being inaccurate. He had found it useful on fixtures for producing close limit components to provide " go " and " not go " gauges for wear on the fixtures, and to have a walking inspector to go round and view all fixtures periodically. One of the reasons why the state of affairs which he had mentioned prevails was that the designer of the fixtures does not give sufficient attention to the ease and speed of replacement of wearing parts, such as pilot bushes and locating faces, etc. That was a very important point in jig design. One came across many cases where it often paid to produce wearing parts for fixtures in quite large quantities, where accurate production is required. It might also be called mass-production of wearing parts. He had in mind a case of a connecting rod fixture in which the holes for the bushes are themselves bushed first. It used to take two or three days to change the

bush in that fixture in the tool room, but now it could be done in an hour or two. The result was that, instead of the foreman being loth to part with his fixture for fear it would hold up production, he was only too glad to send it down to be re-bushed because he got it back very quickly, and production did not suffer in any way. This, of course, was only in connection with fixtures for producing very close limit work. Another matter not mentioned in the paper was the utility of loading plates on fixtures, which was a very important aspect of jig and tool design. He would like a little more information on what appeared to be an ingenious method of drilling out compression chambers. He saw from the illustrations how the horizontal motion was obtained, but he could not see how the motion against the cutter in the vertical plane was kept up.

THE AUTHOR: The cutter gives you the radius.

THE PRESIDENT: This, to my mind, is a very difficult problem in profile milling: to mill in the vertical and the horizontal plane.

Continuing, THE PRESIDENT said his last point was with regard to the cam grinder. The one illustrated had the same inherent defect of all cam grinders, viz., a very small dividing plate had to be used. He could not think why machine tool designers do not design a cam-grinding machine with a hollow head so that a fairly robust extension could be fitted to overhang the dividing plate so that there was plenty of room to make a dividing plate of decent size. He had often thought that would be worth the consideration of designers of cam grinders.

MR. JOHNSON (Associate Member) said that reference had been made to universal joints from floating driving mechanisms for driving bars, etc., for fixtures. Did the author know of a compact mechanism of that type?

THE AUTHOR said he did not think that a compact but perfect universal joint had yet been produced. There were the Oldham type and the Maltese Cross type, which allowed for direct malalignment. These were not absolutely universal, but were the most compact that he knew of.

MR. WEATHERLEY (Member): I cannot understand why the author has to get position on the con. rods after they are assembled.

THE AUTHOR said the problem was to get the big and small end holes accurate in relation to each other within very fine limits, on Duralumin con. rods.

Even if they were machined accurately, they still had to be conveyed from the machine shop to the assembly department. This on such a material as Duralumin led to a possibility of damage or mal-alignment due to the inability of labourers to appreciate the accuracy required and the flimsy nature of Duralumin, and, in

spite of proper conveyors being provided, it was still possible for inaccuracies to be introduced on this account.

Further, although the setting of the con. rods was necessary, he did not necessarily agree that it was the rods which gave all the error.

There were several possibilities for slight mal-alignment, as there were the possible minor inaccuracies in the crankshaft, con. rod, crank case, and cylinder block, and it was extremely difficult to machine four components of this class and of certain design absolutely dead accurate in relation with each other, dead accuracy being required.

Mr. Weatherley said that as Duralumin con. rods were being referred to, that answered his question.

Mr. Gerard Smith (Member) said that, being more interested in the organisation side, he would like to carry the point mentioned by the author as to co-operation between the design and production staff a little further. When a designer designed a mechanism, whether it be in regard to motor cars or anything else, he must, if he be a true designer, know how it was going to be manufactured. Therefore, there must be co-operation. Further, the tool makers should also be allowed to have something to say, yet he had often seen cases where tools had been designed and sent to the tool room, and sent back because it was commercially impossible to produce them. This brought the whole thing down to committee discussion, and there were firms in this country who had adopted this method very successfully. When a new product came out, all these people—the planning designer, the jig designer, the production man, the inspector, and the tool maker—were present and discussed the matter. In organisations to-day the chief thing which prevented this procedure was that every man was overloaded, so that no man in the shop had time to think. There was a foreman, but there was not a departmental superintendent; the foreman could not be released from his duties in the shop in order that he could join this committee. He agreed with the President as to the necessity for avoiding complicated jigs, and his own experience had been similar to that of the President. He had noticed it on many designs of jigs, and particularly in press tools. With regard to first operations, there were cases with which he was familiar which might not, however, occur in motor car manufacture, but he was thinking of fuses during the war, when it did not pay to spend a lot of time on alignment or setting up the part in the first operation, because the value of the material itself did not pay for it. It was better in some cases to scrap, say, 1 per cent. of the castings rather than design and make a jig which required minutes to set it up. One thing he was particularly pleased to see in the author's jigs—although he did not have the same temptations as the man dealing with very light

stuff—and that was the provision of handles on jigs. One had only to see the state of the hands of the operators at the end of a day's work when they had been turning knurled nuts, to appreciate what an advantage handles were.

The Author thanked Mr. Gerard Smith for his instructive remarks and agreed entirely on the question of co-operation.

Committees, within certain limits, was a possible way of dealing with the matter.

At the same time, in the case of a mechanism like a motor car, involving 700 to 800 different parts, he doubted whether it would be possible, or worth while, to have a large committee to discuss every component.

A small committee, constituting the works manager, the chief designer, and the production manager, could view the design from its broader aspect, and then a small sub-committee located in the planning department might deal with the individual parts, planning, etc., and send back their suggestions to the main drawing office for detailed alterations.

Mr. Gerard Smith had also suggested that the man who designs a mechanism should have full knowledge of the production methods, but this seemed rather a big demand for one man. It would be a super-man who could fully cover the production as well as the design in any large concern. At the same time, he agreed that it is essential for the man who is designing a mechanism to know something of the shop. He should have some shop experience and some knowledge of the possibilities of certain shops, so that he did not ask for some operation which would be costly when the problem could be overcome in some simpler and cheaper manner, at the same time not destroying fundamentally the design.

Moreover, queries should be raised by the production department from time to time so that certain problems might be explained to the main drawing office, and perhaps some alternative method suggested. In this way, the original principle of the design might be retained, whilst at the same time assisting the shop.

Reference had also been made to the shop foreman not having sufficient time to think over ways and means of overcoming problems, and assisting, probably, in planning.

That rather depended on how the shop was organised. Some shops allowed foremen to do a considerable amount of planning, etc., but mostly it was found in small shops, and was very profitable where there was a good level-headed, practical foreman who could assist in this way.

In larger concerns, however, a foreman might be installed, not so much as a technical man, but as a minder of production and a disciplinarian, practical engineering knowledge being necessary.

The problems that occurred in the shop could then be handled between the planning department and the jig designer through the

medium of demonstrators, who should be very highly skilled men capable of performing any operation themselves. The correct use of demonstrators serves as the necessary connecting link between the shop and the planning department, and this work handled by capable men does much towards the co-operation which is so necessary between the shop and the jig designer.

With reference to first operations and the suggestion that it would be better to scrap a percentage of castings than make a jig, the point in the Paper on this matter was to get the first datum so that in subsequent jigging from the spigot or bore, the component would be cared for for accuracy, and that the holes would be in the centres of bosses, etc., on future operations, especially in the cases of intricate castings. Therefore, in making a jig for the first operation, the object was accuracy, and to take into consideration some boss, face, or flange which had to be machined on another machine in a subsequent operation.

Mr. Storey (Member) said that with regard to locating from some specific datum line he had recently had two cases in which the fancy flange or moulding put on to components for enhancing their appearance had been used as a location, with the result that the holes were as much as $\frac{3}{8}$in. out of the centres of the bosses. By putting V's locating from the main and greatest spaced bosses that trouble was overcome and perfect work resulted.

In reading the paper, the author had stated that in locating a component, it was necessary to have three faces in one plane and only two in the other plane.

The speaker did not quite understand this, because he did not understand how the work could be located without having three locating points in each place.

With reference to locating components by bores on to spigots fixed in the fixture, the author had mentioned that it was preferable to use loose pegs. Whilst agreeing, it was necessary to state that one has to be very careful to take into consideration that there must be a tolerance between the peg itself and the bush into which it fits; hence loose pegs in themselves caused losses in accuracy.

One of the slides showed an indexing plunger, that was on the top of a milling fixture and thus in an ideal position to catch swarf, a trouble which could easily have been avoided by putting it underneath, or at least covering it. The practice of the speaker was to build the plunger into the fixtures so that it was impossible for swarf to reach it.

Further, the plunger shown had taper sides, and the speaker was of the opinion that plungers should always have parallel sides, as there was no guarantee that a taper plunger was home, whereas with a parallel plunger, if it entered even a little, the work was accurately located.

Parallel plungers should, however, have a trailing and a leading edge.

In one or two of the lathes and revolving fixtures which the author had illustrated, there were screws protruding in a very dangerous manner.

Very great care should be taken to avoid projecting screws, and, in fact, all projections on revolving fixtures, as they are a source of very great danger to the operator, causing bodily injury and at least torn clothing.

The author agreed that the third point in the horizontal plane constituted a location.

The loose pegs he had referred to only related to large castings where the pegs were a good distance apart, and it was felt that the small tolerance which would exist between the peg and jig was preferable to a greater error which might be created by forcing the component on to two fixed pegs.

The taper plunger on the particular jig in question was felt to be one which would maintain accuracy longer under certain conditions.

With regard to projecting screws on rotating jigs, every endeavour should be made to avoid these, but there were occasions when certain projections were difficult to avoid.

Mr. Whitaker (Member) said that while he was very interested in the discussion upon the details of tool and jig design, he was more particularly so in the broad principles of the control of the same. As regards planning, one of the chief points was to win the co-operation of the section foremen, that had always proved to him to be a very satisfactory course, because the man who had the job to do was vitally concerned with the difficulties that may arise.

With reference to fixing of limits, he did not altogether agree that these should be fixed by the car (or machine) designer entirely, but should be settled only in close co-operation with the production engineer (planning engineer or chief tool designer, as the case may be) as the latter had a great deal better knowledge of what could actually be done in the shops than the car designer could be expected to have.

One point of importance in the control of tool design, which had not been mentioned, was the value of correct estimating, both of the cost of the tool itself and the comparative costs of the operations as carried out by one type of jig as against another. If a more elaborate but quicker jig was contemplated, it was necessary to know exactly what would be the saving by adopting it.

Mr. Gartside (Member) said that one of the things to be emphasised is simplicity in the design of jigs and tools. Personally, he felt that we had been passing through a transition stage in this country during the last five years, as far as manufacture

is concerned. Before the war there was not the amount of mass production going on that there is to-day, and we seemed to be drifting into a mass-production country. Everyone who had anything to do with manufacture now thought of how many articles have to be made in order to make them pay. Of course, if markets were available, that principle was sound. A certain amount of trouble now being experienced in this country was due to lack of co-operation in the manufacturing organisations themselves. No doubt that was partly due to the change over that was taking place throughout the country, and whether the idea of mass production would suit the British temperament remained to be seen. Some of our troubles were undoubtedly due to the fact that we had not yet learned how to fit in with the new ideas that are being adopted, and there was too much tendency in his opinion to bring the various departments into water-tight compartments. There was the production engineer, the planning engineer, the shop foreman, etc., and they all seemed to be working in their own little sphere. The shop foreman must not interfere with the designer, and so on, and this has been going on for a sufficient length of time to introduce a strained feeling betweeen the different departments in the works. His idea of getting over that was to change the men about a bit. For instance, the man who designed a jig should be able to do the first operation on it, and to show the operator in the shop how it should be done. The difficulty was that so many designers were not practical men, and the system he advocated, which was adopted in his firm, was that draughtsmen had to spend two or three years actually working on machines, so that they knew how parts can be produced. It was most important that the designer should be capable of doing the practical side of the work himself, and if this policy were extended it would result in much greater simplicity in jigs and machines generally. One could still go round a works and see perhaps a milling machine with about twenty different speeds and twenty different feeds, where only one or two had been used for a considerable time. For mass production purposes this type of machine would have to be cut out and very much simpler types of machines, with good, plain and substantial working parts, substituted which would stand up to the job for a reasonable length of time. The President had mentioned in his Presidential Address the need for co-operation between the users of machines and the makers, and there were many cases in which machine tools had been considerably improved by the makers owing to the assistance received from the purchasers of them, as the result of their experience with them. A point to be driven home was that users do not always realise that machine tool makers are not, in many cases, users of the machines they make. The machine tool makers are called upon many times to design special machines, and are asked to

quote for machines to manufacture parts to a drawing, and probably when the machine was made it was found it did not fit in with what was wanted, and then there was trouble. It was very unfair to the machine tool maker to expect him to build these special classes of machines and to know everything about the job it was to do. Therefore, there was great need for co-operation between the users and the makers. With regard to the committee in the works suggested by Mr. Gerard Smith, his opinion was that we are getting far too many committees which do a great deal too much talking. His idea was to get on with the job. In many works the heads of departments sat round a table talking and talking, whilst the job in the works was being neglected. It was impossible to have a man on this committee and in the shop at the same time. At the present moment accuracy was being called for more than ever, and he was a great advocate of accuracy where it was required, but his experience with most draughtsmen to-day was that when they were even designing a wheel barrow they would give dimensions to half a thou. (Laughter.) There was not sufficient distinction made between one thing and another, and he had seen dimensions with five places of decimals on a drawing that would not matter if they were to one place of decimals. It was simply because a draughtsman had seen it in a book somewhere, and this, of course, brought him back to the point that draughtsmen in too many cases were not practical enough. Another difficulty to-day was that measuring instruments are about twenty years ahead of manufacture. Instruments were now available which would measure to a millionth of an inch, but it was another matter making to that accuracy. That was a point worth considering, because there was a danger of going too far in this matter of accuracy, and the average designer to-day did not know where to draw the line.

THE AUTHOR said that Mr. Gartside's remarks would be very helpful indeed, coming as they did from one who had had experience in these matters. There could be no disagreement with the argument in favour of simplicity, but an instance of what he meant by "necessary ingenious design" was afforded by the sleeve valve engine cylinder. This might be a complete cylinder block which allowed for no normal methods of machining the valve ports inside. Therefore, the jig designer had to use an idea which was ingenious, and which prevented the jig from being simple; at the same time the general argument in favour of simplicity was perfectly sound.

Undoubtedly the man designing jigs should have had good shop training and experience. As regards the jig designer himself operating the jigs, it was thought that the designer's wishes could be interpreted to the shop through the medium of demonstrators, leaving the designer free to carry on with his more normal func-

tions, but the designer should give sympathetic consideration to the demonstrator's recommendations.

As to the relations between the users and the makers of special machines, it was necessary for the users to give as much information to the makers, and to help them as much as possible, especially with the first machine of a new class, and the makers should be prepared to work a special machine under its normal conditions, and not hand the machine over until the required result was achieved.

MR. GARTSIDE, interposing, said that, whilst there was a willingness to do this on the part of makers when the machine had been in production for some time, and they knew what it would do, they were not so keen when it was their first machine.

THE AUTHOR, referring to the committees which had been mentioned by one or two speakers—he assumed always small committees—said he certainly failed to see how co-operation could be fully effective unless the responsible heads conferred together in some form; such conference, whether it were carried out in an office or in the shop, might still be termed a committee.

MR. GARTSIDE: I agree with a small committee.

THE AUTHOR agreed that there was a tendency in the drawing office to give limits to drawings much closer than were necessary, and he instanced a case known to him of an exhaust pipe which had a limit of plus or minus 0·010in., whereas the limit might have been plus or minus an inch. This question showed the need for that necessary practical experience suggested for the main drawing office, and the detailed suggestions put forward by the production department should assist the main drawing office to gain experience in this direction.

MR. MANTELL (Associate Member) said that, whilst emphasis had been placed on the necessity for referring limits back to the drawing office when they were thought to be totally unsuitable for the equipment available, the point to be remembered was that presumably the designer was interpreting the policy of his firm in designing certain mechanisms within certain limits. In many cases designs were referred back more to save trouble than because it was not possible to carry them into effect. Therefore, the attitude which seemed to have been emphasised during the discussion appeared to him to be a negation of the policy laid down in the Presidential Address, viz., that the production engineer should say that nothing is impossible. He agreed that practical considerations do at times make some things impossible, and, if the plant cannot produce to the limits which are called for, then it is up to the works to go to the directorate and say that the policy as interpreted by the designer cannot be carried out unless other equipment is provided. If the attitude of mind which had been expressed several times during the discussion was insisted upon,

progress would seriously be hindered. With regard to the committee question, it seemed to him that, when it was suggested that a committee should be formed, ranging from the chief designer down to the machine shop foreman or even the charge hand, then we were getting to something like a Soviet Government, which in itself had not proved very successful. The designer, the works manager, and the production engineer, were the three men who should put their heads together to see if a policy could be carried into effect. The foreman surely was there to see that what the production engineer and the designer said should go must go. If everybody else was to have a say, and many of them said the programme was not possible, production would never be got on with at all. In any case, the formation of some committees struck him as not only not leading to really effective co-operation, but prompted the tendency to place the blame on somebody else's shoulders when things went wrong.

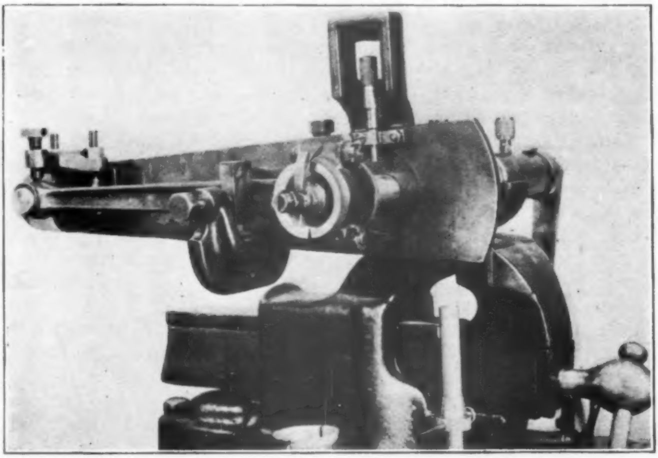
THE AUTHOR replied that when he spoke of referring back to the main drawing office he did not have in mind the fundamentals of the design, but only details. In any case, the production department should not interfere with the fundamentals of design, especially on quality cars as mentioned in the paper.

THE PRESIDENT, in drawing the discussion to a close, said that, as regards the question of fixing limits, it was obvious that the chief designer could not be as expert at actual production work as the chief tool and jig designer, who was much nearer the bone. Therefore, if he saw anything in the drawing which appeared unreasonable, or that the limits were much closer than necessary, or that a particular design was very costly to machine, it should be his duty to refer it back to the chief designer; but in the absence of any such points he agreed with Mr. Mantell that progress could only be made by following out the requirements of the drawing office. After all, when we compared the motor car of twenty years ago with the motor car of to-day, what had brought about the change? It was accurate production, and we could not get the performance out of cars that we do to-day if it were not for accurate production, not only in the production of the machine but of the steel, and accuracy in the treatment of steels that we use and in the handling of them. As to committee work, in all large organisations there were heads of departments who had been appointed because they were supposed to be able to carry out their jobs. In the course of their work they must inevitably constantly be consulting with the heads of other departments. Such consultations may be called committee meetings, but you are not going to call in the foremen in such discussions nor all the rest of the staff concerned. When a settlement is arrived at, surely it would be the duty of the production engineer to interpret the decisions by means of instructions to his staff. He had seen

innumerable committees on the lines that had been indicated during the discussion, but he had never found one that had been a bit of good. Such committees always subordinated the responsible heads, and made it more difficult for them to control the staffs which have to carry out the work. Personally, he was thoroughly averse to committees, possibly because he had been called in on so many of them and, in his opinion, quite uselessly.

A cordial vote of thanks was passed to the author at the conclusion of the discussion.

A HAND BORING TOOL.



For boring connecting rods after re-metalling, the tool shown in the above illustration presents some interesting points. A hand driven boring bar with automatic feed mechanism is used, and the small end of the rod is located by means of a gudgeon pin gripped between V blocks on an adjustable bracket. The big end of the rod is centred by using the boring bar as a datum. A micrometer mounted on the fixture above the boring bar provides for setting the cutter, which is of standard shape and is supplemented by radius cutters for finishing the ends of the bore.

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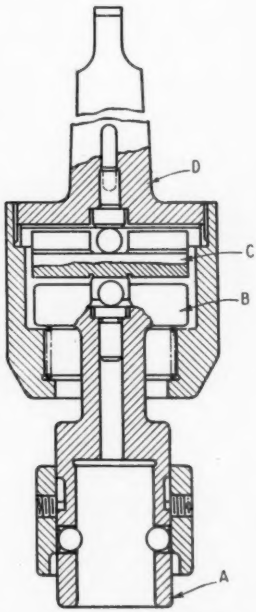
A Fully Floating Chuck.

IN his interesting paper on "The Design of Jigs and Special Purpose Machines," read before the Institution, Mr. Hancock remarked on the necessity for a fully floating device as a drive for boring bars, reamers, etc., when used in conjunction with line boring and reaming fixtures. It is, of course, obvious that the provision of accurate jigs is of very little use if the possibility of outside interference exists, as it must do if boring bars or reamers are working in a strained position. The writer has had extensive experience of the class of work Mr. Hancock had in mind; for instance, the boring of gear boxes or crank cases—jobs in which absolute lineability of bores is essential—and he is in full agreement with Mr. Hancock as to the desirability of providing an efficient drive of the type suggested.



A useful floating chuck.

The device must be light and compact, yet capable of carrying fairly heavy loads. It must be so designed that bars can be rapidly and safely engaged and disengaged. Chucks of the Barnes quick-change type are generally used for this class of work, and at first sight would appear to be a satisfactory solution of the problem. On investigation it will be found that the floating action of this type of chuck is strictly limited, its real action being of a pivotal nature, whilst, when actually driving, a certain amount of locking action occurs between the driving keys and the flats on the bar being driven. As the relative positions of the jig and driving spindles frequently vary during the travel of the carriage along the bed of the machine, it will

be appreciated that the limited floating action of the chucks is, or at least may be, a serious matter. Rapid wearing of jig bushings and boring bars occurs, and the initial accuracy of the jig is impaired.

The chuck illustrated is designed to overcome the troubles described above, whilst still maintaining the advantages of rapid engagement and release of boring bars. The front portion A is a Barnes chuck in principle, with the addition of a flange B formed at the back end of the shank. This flange is milled to accept one tenon of the coupling C, which is a circular disc having two tenons milled at right angles to one another. A driving shank D is milled to suit the second of these tenons, thus forming in effect an Oldham coupling. Both faces of the member C are recessed to receive two hardened steel balls, whilst the shank D and the flange of the chuck are counter-bored and fitted with hardened steel plugs. These take the pressure of the balls when the chuck is in action.

The depths of the recesses are so dimensioned that, when assembled, the balls maintain a clearance of $\frac{1}{32}$in. between faces of shank, chuck, flange, and coupling. This gives a free floating movement, and also allows for a reasonable amount of pivoting action. On the outside the shank D is threaded to suit the cap E, which is bored so as to allow the necessary sliding movement to occur between chuck, coupling, and driving shank. It is also recessed to take a coil spring of sufficient strength to hold the floating components together when at rest. The cap when screwed home abuts on the front face of the driving shank, and the depth of bore should be so arranged that under no circumstances can the tenons be disengaged from the slots in the coupling. All component parts should be hardened and ground.

MONTAGUE JOHNSON (Associate Member).